

**NANYANG
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Experiment 1: Parametric Curves

CZ2003 Computer Graphics and Visualization

SS3

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1 DEFINING SHAPES PARAMETRICALLY

1.1 Straight Line Segment

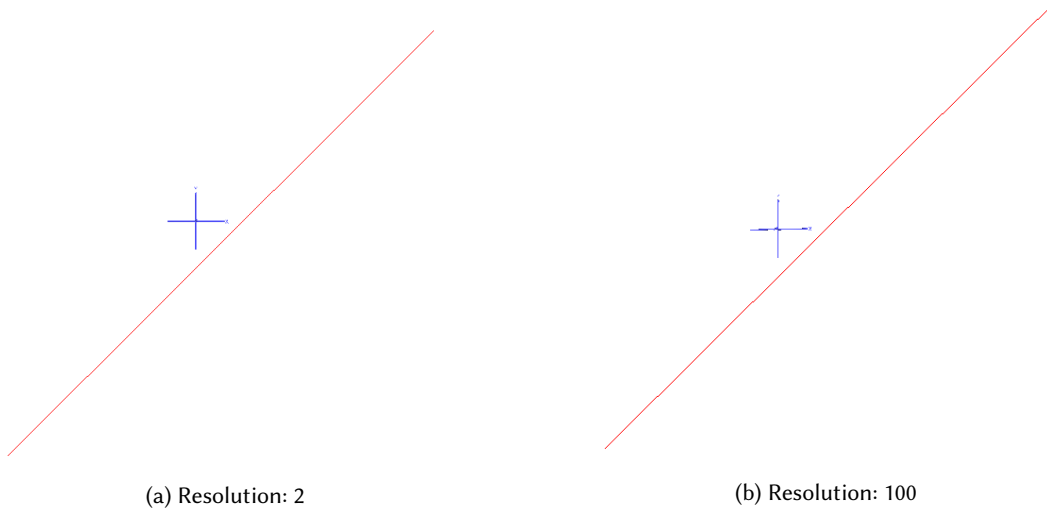


Fig. 1. Plots of the straight line segment defined in "**1a.wrl**" with differing resolutions

As seen in Fig. 1 above, a sampling resolution of **2** is sufficient for drawing a straight line segment.

1.2 Circular Arc

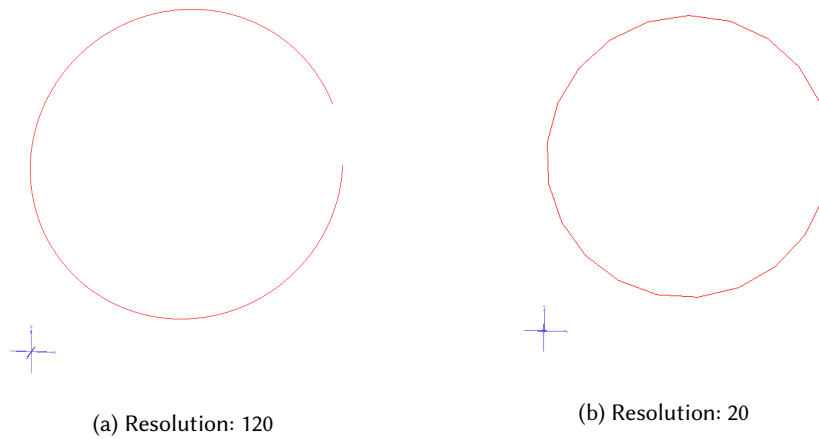


Fig. 2. Plots of the circular arc segment defined in "**1b.wrl**" with differing resolutions

As seen in Fig. 2 above, a higher sampling resolution of **120** is required for drawing the circular arc in order for it to appear as a smooth arc. When the sampling resolution is reduced to 20, the polyline interpolation of the curve is revealed.

1.3 2D Spiral Curve

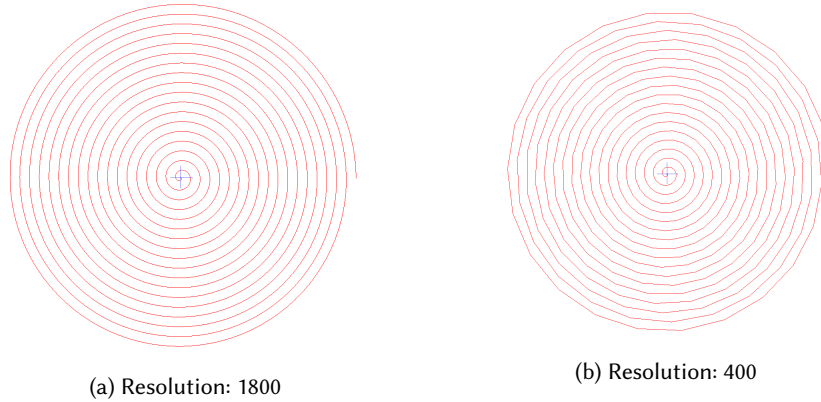


Fig. 3. Plots of the spiral curve defined in "**1c.wrl**" with differing resolutions

As seen in Fig. 3 above, a much higher sampling resolution of **1800** is required for drawing the spiral curve in order for it to appear smooth. This is due to the fact that the spiral has a large number of spirals (18), and therefore the sampling locations on the outer part of the spiral are further apart as compared to the inner part of the spiral.

This can be seen when the sampling resolution is reduced to 400 in Fig 3b, the inner parts of the spiral appears smooth, while the polyline interpolations can be seen on the outer parts of the spiral

1.4 3D Cylindrical Helix

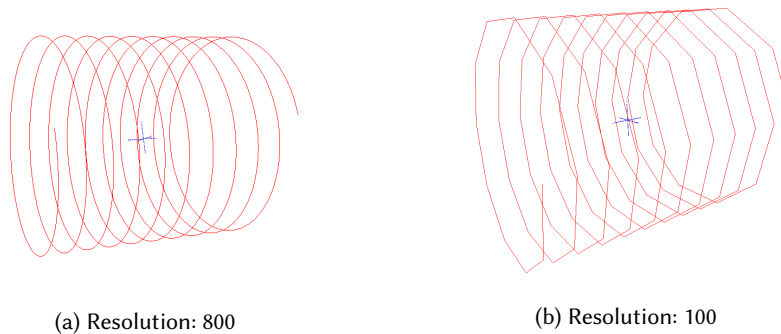


Fig. 4. Plots of the cylindrical helix defined in "**1d.wrl**" with differing resolutions

As seen in Fig. 4 above, a much higher sampling resolution of **800** is required for drawing the cylindrical helix in order for it to appear smooth. When the sampling resolution is reduced to 100, the polyline interpolation of the curve is revealed.

2 CONVERTING EXPLICITLY DEFINED CURVE TO PARAMETRIC REPRESENTATIONS

For this task, an explicitly defined curve has to be converted to its Parametric Representations. The following explicitly defined curve was assigned:

$$y = \tanh x$$

$$x \in [-1.3N, 2N], \text{ where } N = 8$$

Therefore, the follow parametric functions can be obtained:

$$x(u) = (-1.3 * 8) + u * ((2 + 1.3) * 8)$$

$$\mathbf{x(u)} = -10.4 + 26.4 * \mathbf{u}$$

$$\mathbf{y(u)} = \tanh(-10.4 + 26.4 * \mathbf{u})$$

$$u \in [0, 1]$$

By plotting the parametric equations defined above, we get the following display:



Fig. 5. Plot of the parametrically defined curve in "2.wrl"

3 CONVERTING CURVE DEFINED IN POLAR COORDINATES TO PARAMETRIC REPRESENTATIONS

For this task, a curve defined using polar coordinates has to be converted to its Parametric Representations. The curve is defined by:

$$\begin{aligned} r &= N - (M + 5)\cos\alpha \quad \alpha \in [0, 2\pi], \quad N = 8, \quad M = 10 \\ r &= 8 - (10 + 5)\cos(\alpha) \\ r &= 8 - (15)\cos(\alpha) \end{aligned}$$

We can convert between polar to cartesian with the following formulas:

$$\begin{aligned} x &= r\cos(\alpha) \\ y &= r\sin(\alpha) \end{aligned}$$

Therefore, we can get:

$$\begin{aligned} x(\alpha) &= (8 - 15\cos(\alpha))\cos(\alpha) \\ y(\alpha) &= (8 - 15\cos(\alpha))\sin(\alpha) \\ \alpha &\in [0, 2\pi] \end{aligned}$$

Converting domain from α to u :

$$\begin{aligned} \mathbf{x}(u) &= (8 - 15\cos(2\pi u))\cos(2\pi u) \\ \mathbf{y}(u) &= (8 - 15\cos(2\pi u))\sin(2\pi u) \\ u &\in [0, 1] \end{aligned}$$

By plotting the parametric equations defined above, we get the following display:

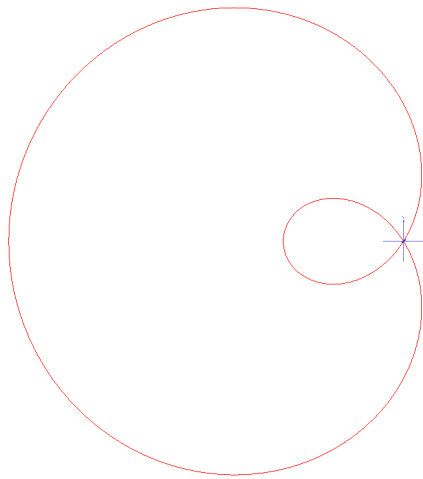


Fig. 6. Plot of the parametrically defined curve in "3.wrl"